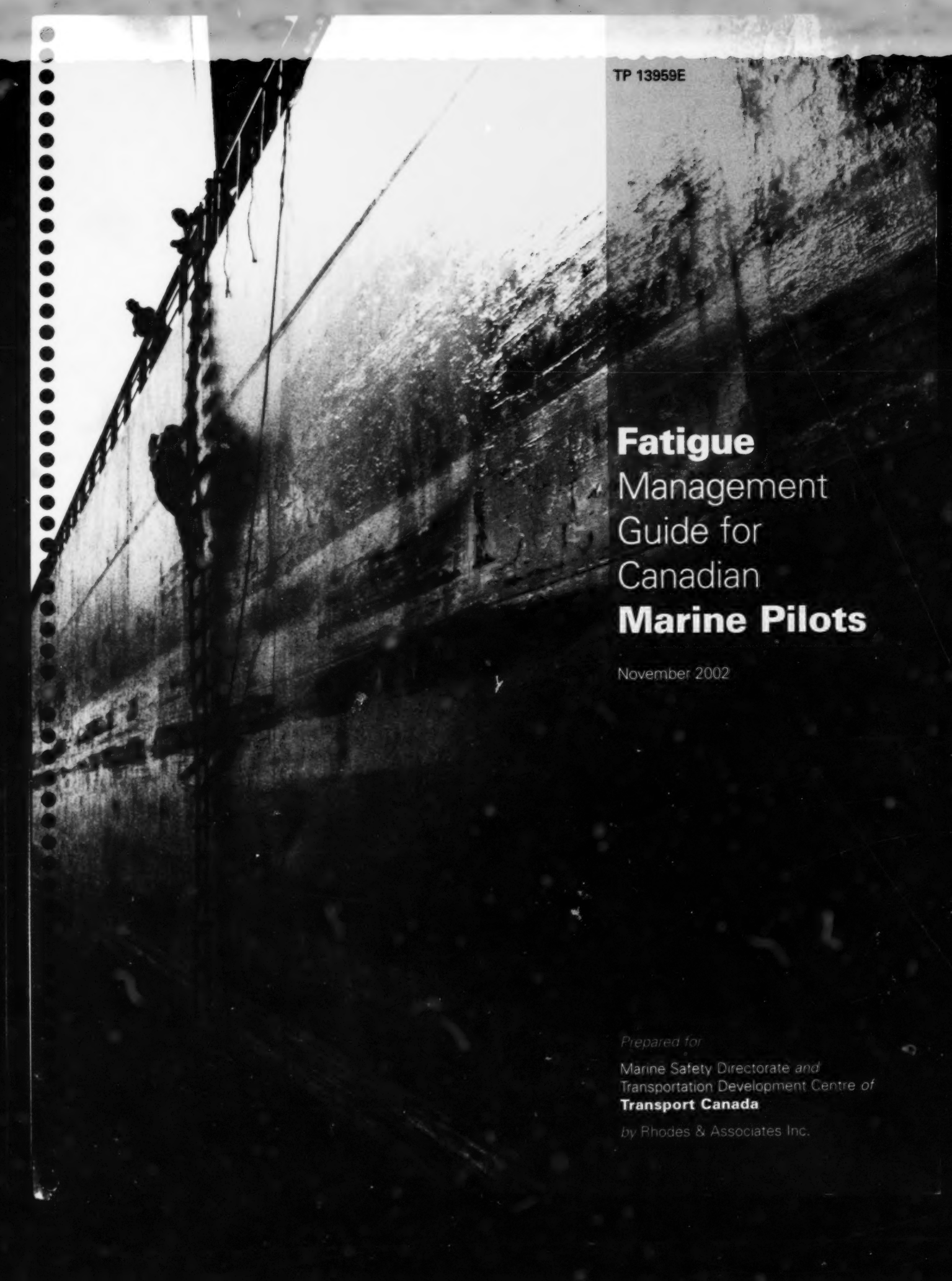

TP 13959E

Fatigue Management Guide for Canadian **Marine Pilots**

November 2002

Prepared for

Marine Safety Directorate *and*
Transportation Development Centre *of*
Transport Canada

by Rhodes & Associates Inc.

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TP 13959E

Fatigue Management Guide for Canadian Marine Pilots

Prepared by
Wayne Rhodes and Valérie Gil
Rhodes & Associates Inc.

November 2002

This report reflects the views of the authors and not necessarily those of the Transportation Development Centre or the Marine Safety Directorate of Transport Canada.

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Wayne Rhodes, Ph.D., C.P.E.
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Preface

This guide is part of a fatigue management program that was developed for Transport Canada by Rhodes & Associates Inc. The development of the program involved two phases:

1. Research into fatigue issues in marine pilotage; and
2. Development of a fatigue management program (FMP).

The program consists of three components:

a. FMP implementation plan;
b. FMP training module; and
c. FMP guidelines for scheduling pilots and for monitoring and evaluating the FMP.

Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook, TP 13960E, is the primary reference tool for the trainer responsible for the marine pilot fatigue management training module.

Fatigue Management Guide for Canadian Marine Pilots, TP 13959E, is the guide for participants in the six-hour training workshop.

Background material and supporting research is found in *Development of a Fatigue Management Program for Canadian Marine Pilots*, TP 13958E.

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DESCRIPTION OF THE GUIDE

Purpose of the Guide

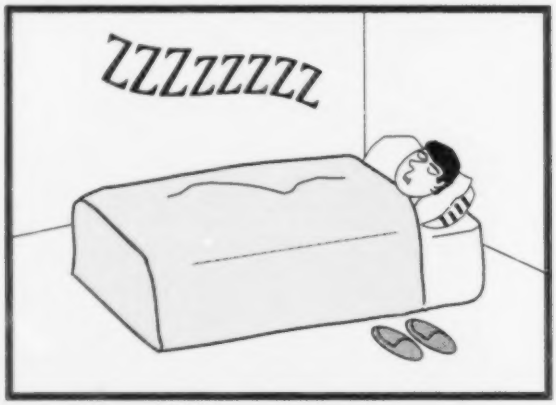
This guide was prepared by Rhodes & Associates Inc. for the Transportation Development Centre and the Marine Safety Directorate of Transport Canada to be used by marine pilots and trainees in the fatigue management educational workshop (Marine Pilot Fatigue Workshop). It provides the background information needed to understand the basic concepts learned in the six-hour workshop, and is designed to be used as a reference and guide.

Components of the Guide

The *Fatigue Management Guide for Canadian Marine Pilots* deals with four important areas:

1. Sleep Fundamentals
2. Biological Clock
3. Effects of Irregular Work Shifts
4. Coping Strategies

SLEEP FUNDAMENTALS



Sleep Necessity

Sleep is as necessary as food or water, and no matter how much we try we cannot eliminate the need for sleep. We cannot reduce the amount of time we spend asleep without adverse consequences. Without sufficient sleep we can quickly become vulnerable to illnesses, errors, and accidents. Alertness and performance are directly related to quality and quantity of sleep.

Sleep Stages

Our sleep can be separated into two types:

- **Non-Rapid Eye Movement** sleep (Non-REM sleep) and
- **Rapid Eye Movement** sleep (REM sleep).

Non-REM sleep: Non-REM sleep comprises four sleep stages. Stages 1 and 2 are light sleep and stages 3 and 4 are deep sleep.

When you fall asleep you usually fall asleep in stage 1. If someone wakes you up during stage 1 you will often deny being asleep. Research has shown that individuals asked to press a button in response to a signal (auditory or visual) will stop responding when entering stage 1. Very brief periods of stage 1 (20 to 30 seconds) during your time awake are known as **micro-sleeps**. These micro-sleeps are often not remembered. Therefore, you can be asleep without really knowing it.

After five to ten minutes of stage 1 you will reach stage 2 sleep. This is considered the first real period of sleep. By the end of your entire sleep period you will have spent half of it in stage 2.

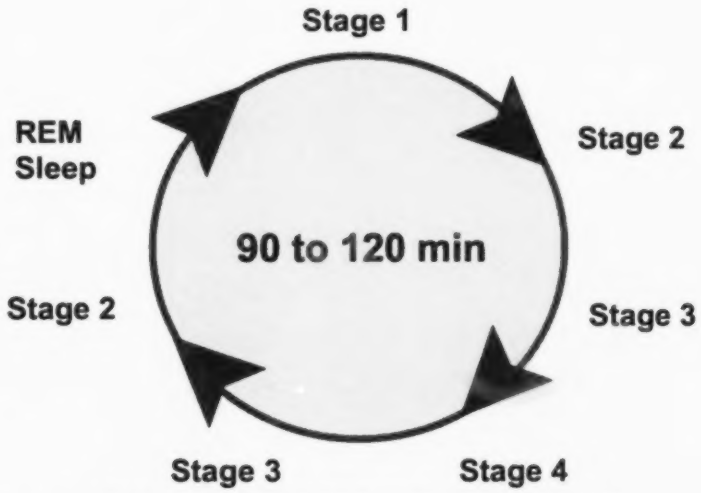
As the sleep period continues you will enter stage 3 sleep and finally stage 4. It is very hard to wake up from stages 3 and 4 (deep sleep) and if awakened you will feel groggy, disoriented,

and your performance will be impaired, a condition called **sleep inertia**. This phenomenon can last for 15 minutes or more. Stages 3 and 4 are also the stages of sleep when sleepwalking, bedwetting, night terrors, and talking may occur.

REM sleep: After 70 or 110 minutes of Non-REM sleep you will enter REM sleep. This is where most of your dreaming occurs, which is why it is often called dream sleep. During this stage your brain is very active but your body is paralyzed. All voluntary muscles except those controlling the eyes, your breathing, and your heart are turned off so as to prevent you from acting out your dreams. Terrifying dreams or nightmares occur during REM sleep.

Sleep Cycle

We sleep through a defined, repetitive cycle. Sleep stages occur in the specific sequence or cycle shown in Figure 1. Each cycle takes approximately 90 to 120 minutes. Often we go through four to five of these cycles per sleep period. Stage 1 doesn't occur in each cycle unless you have awakened during your sleep.



Adapted from *Shifting to Wellness*, Keyano College, 1995.

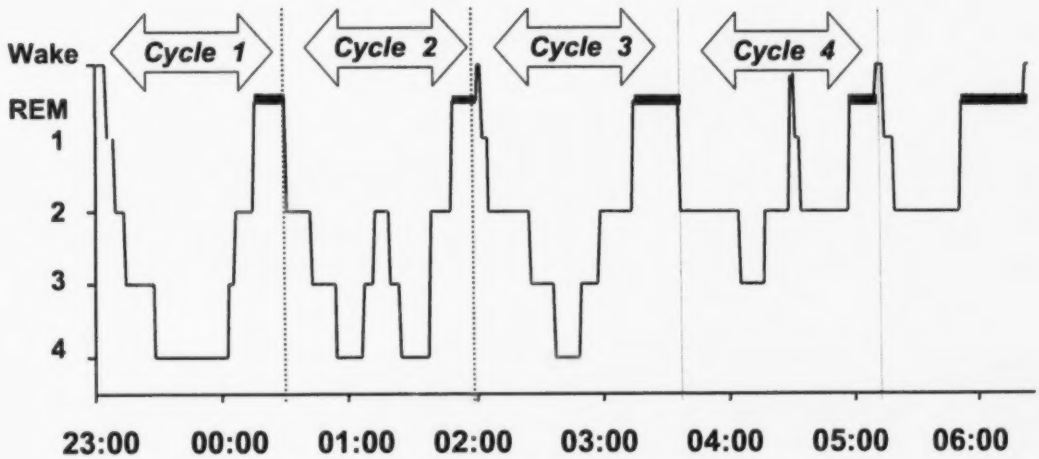
Figure 1 – The Human Sleep Cycle

Sleep Structure

A hypnogram is a graphic representation of a sleeping period, showing the timing, duration, and sequence of every sleep stage an individual has throughout each consecutive cycle. Note that:

- Time spent in stages 3 and 4 (deep sleep) is longer during the beginning of the sleep period.
- Time spent in REM is longer toward the end of the sleep period.

Figure 2 shows the different stages of sleep, throughout each of the sleep cycles during a typical night's sleep.



REM sleep is indicated by the heavy bar

Figure 2 – Hypnogram for Nighttime Sleep

Sleep Requirement

Do you get enough sleep? Most adults require between seven and nine hours of sleep every 24 hours.

Age affects how much sleep you need and how much you can manage to get. Age also affects how you obtain your required sleep, i.e., whether you get your sleep all at once in a single sleep period or whether you augment your sleep with naps.

Sleep duration varies with age (see Figure 3). You start out requiring a very large amount of sleep, then by the time you are in your 60s you sleep less than half of that. Some of this drop in sleep is due to a reduced requirement, but a significant reduction is the result of your body clock becoming less efficient and flexible as you age.

Sleep structure also varies with age. Babies have more REM-like sleep than adults. Non-REM sleep has been reduced by as much as two hours at age 60.

NOTE: Most marine pilots are between 40 and 60 years of age.

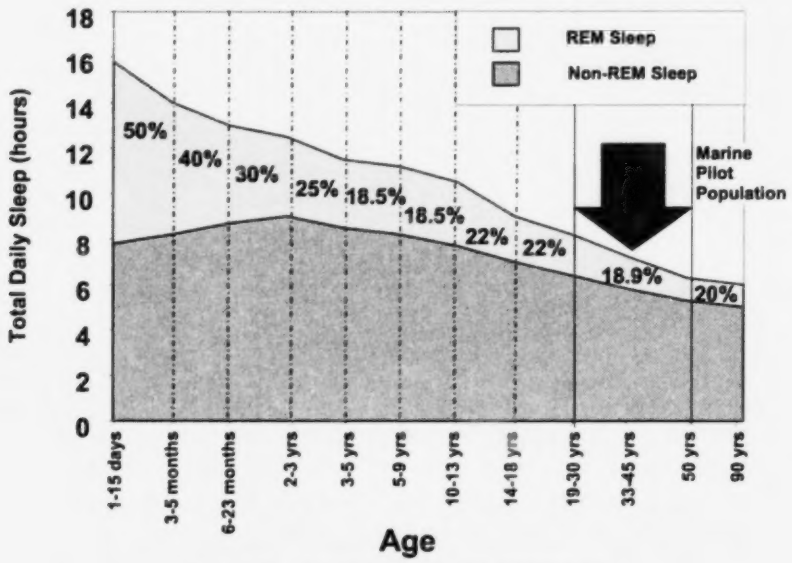


Figure 3 – Amount of Sleep Obtained

Ask yourself the following questions to see whether you get enough sleep.

1. Do you show any signs of sleepiness?
   - Do you often sleep longer by an hour or more on your days off?
   - Do you sometimes fall asleep when you didn't intend to (at the movies, in meetings)?
   - Do you fall asleep in less than 5 minutes?
   - Can you nap any time, any place?

2. Do you know how much sleep you really need?
   - Experiment to see how much sleep you need to feel alert on the job. Keep track of the hours you actually sleep. You may be sleeping less, or more, than you think.

If you find that you sleep an adequate number of hours but still feel exhausted, you need to find out whether you have a sleep disorder. Consult your doctor for proper diagnosis and treatment.

Sleep Disorders

One factor that people often overlook when they sleep poorly is whether they may have a sleep disorder. If they do, even good sleep habits and practices are not enough to get the proper amount and quality of sleep. A sleep disorder must be properly investigated and diagnosed by a qualified physician. The most common sleep disorders are: insomnia, sleep apnea/hypopnea, narcolepsy, restless legs and periodic limb movements in sleep, and delayed or advanced sleep-phase syndrome. If you think you have a sleep disorder, see your doctor.

Insomnia

Insomnia is the most common sleep problem among people who work irregular shifts. Insomnias include: difficulty falling asleep or staying asleep, or waking up too early. Insomnia can be chronic, lasting more than two weeks, or intermittent, lasting a few nights. Chronic insomnia can be caused by depression, anxiety or stress, leg movements, medical problems, poor sleep habits, or irregular sleep/wake schedules. Intermittent insomnia is usually caused by stress or worry. Prescribed sleeping pills can help treat insomnia for a short time only.

Sleep Apnea/Hypopnea

Sleep apnea/hypopnea is common in men over 40 who snore, have a neck size of 17 or more, and are overweight. The sleeper stops (apnea) or reduces (hypopnea) his/her breathing, reducing the level of oxygen in the blood. The sleeper wakes up suddenly choking or gasping to take a breath and falls back to sleep immediately. As a result, people who suffer from sleep apnea are unaware of it, because the awakening is very brief. The process can start over several hundred times a night, resulting in a very disrupted sleep structure. People with sleep apnea suffer from excessive sleepiness and fatigue, and they can fall asleep easily in routine, non-stimulating activities such as driving or watching TV or movies. Other symptoms include personality changes, headaches, poor memory, irritability, and decreased sex drive. Sleep apnea can be associated with serious health problems, such as heart failure. Sleep apnea can be successfully treated.

Narcolepsy

People who have narcolepsy suffer from uncontrollable sleep attacks that occur several times a day. The sleep episodes typically last a few minutes and are described as fully recuperative. They usually recur after several hours. In addition to sleep attacks, patients report sudden muscle weakness lasting a few seconds, triggered by sudden emotion. This is referred to as cataplexy. Narcolepsy is not common, but the symptoms cause severe problems for sufferers. Usually the excessive daytime sleepiness is a lifetime condition, while cataplectic attacks can vary in frequency. The cause is unknown, but narcolepsy can be controlled with medication and lifestyle changes.

Restless Legs Syndrome and Periodic Limb Movements in Sleep

Restless legs syndrome is a neurological condition experienced as tingling, crawling, or prickling sensations in the limbs (usually the legs), causing the sufferer to want to get up and move around. Usually the symptoms peak at the end of the day or at bedtime and can make it very difficult to fall asleep. Often restless legs syndrome will be associated with periodic limb movements, characterized by repeated limb jerking (usually of the legs) during sleep. This jerking can happen as often as every 20 to 40 seconds, disrupting sleep and causing fatigue. Sufferers also have difficulty falling asleep and staying asleep. Sometimes patients complain of daytime sleepiness instead of chronic insomnia.

Prescription medication is used to treat the symptoms.

Delayed or Advanced Sleep-Phase Syndrome

Two syndromes can occur when a person's biological clock is slightly out of synch with the environment (normal day). People who have difficulty going to sleep at night, and can only fall asleep in the early morning hours, may be suffering from delayed sleep-phase syndrome. Indeed, delayed sleep phase syndrome is the most frequent disorder of the circadian system and is generally seen in adolescents and young adults who have difficulty waking up in the morning and attending school or work. These persons can be described extreme night owls. In comparison, advanced sleep phase syndrome is usually seen in older people who have trouble staying awake in the evening and wake up too early in the morning. These persons can be described as extreme morning larks (early risers) and have tremendous difficulty adapting to evening or night shifts. This syndrome should be distinguished from depression that can also be associated with early morning awakenings. Both of these syndromes are associated with difficulties adjusting to the conventional schedule and are typically difficult to treat. Bright light therapy given at the right time of day can help the sufferers of both syndromes keep their biological clocks in synch with their environment.

Sleep Quality and Quantity

Quality of sleep is as important as amount of sleep. Not all sleep is of the same quality and not all sleep provides the same recuperative benefits. Sleeping at times other than at night will result in a much more disrupted, shorter sleep and an altered sleep structure. Hence, the quality of daytime sleep is lower than that of nighttime sleep. Recuperative sleep also requires an individual usually sleeping eight hours per night to have at least six hours of uninterrupted sleep, which can be difficult to get at certain times of the day.

You can take a number of actions to improve your sleep quality and quantity:

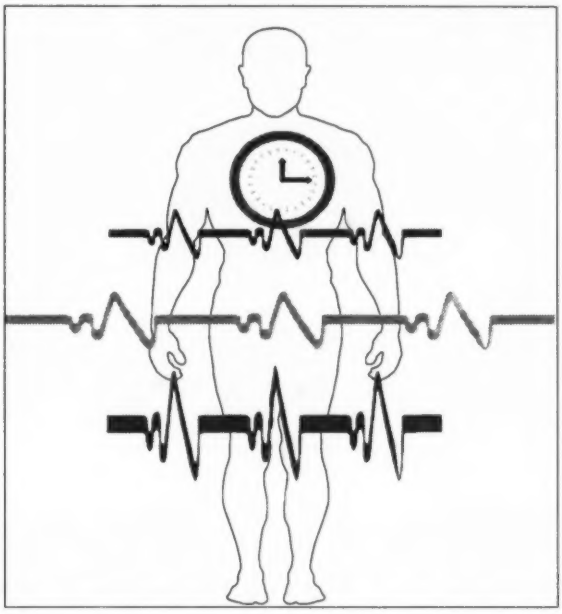
- Follow good sleep habits.
- Create a quiet, dark, and comfortable sleep environment.
- Make lifestyle choices that help you get the sleep you need.

These suggestions are detailed in Coping Strategies, page 27.

What to Remember about Sleep

- You cannot eliminate your body's need for sleep.
- Most people need between seven to nine hours of sleep a night to be fully alert and able to perform well.
- As you age, the duration and structure of sleep changes.
- Sleep quality is as important as sleep quantity.

BIOLOGICAL CLOCK



Biological Clock and Rhythms

The human body has been programmed to sleep at night and stay awake during the day. One set of your biological rhythms regulates your behavioural and physiological processes to be more active during the day and less active during the night. This set is called "circadian rhythms" because they are body rhythms that are completed in a day (from the Latin circa, meaning around, and dies, meaning day). Biological rhythms and processes are synchronized with each other and the environment so the body can work efficiently, doing the right thing at the right time, but with some flexibility. Your biological clock controls and synchronizes the timing of biological processes, such as heart rate, digestion, and body temperature, so they are more responsive and active during the day and less responsive and active at night. When you change the time you sleep and wake, you work against your biological clock, disrupting the synchronization of biological processes. In other words, loss of sleep is not the only problem resulting from changing your sleep/wake schedule.

It takes approximately one day for some rhythms to adapt to a time change of one hour; other rhythms may take a longer or shorter time to adjust.

Understanding the importance of biological rhythms in your daily functioning and knowing how they respond to disruptions will help you find ways to function effectively under less than ideal conditions.

Time Cues

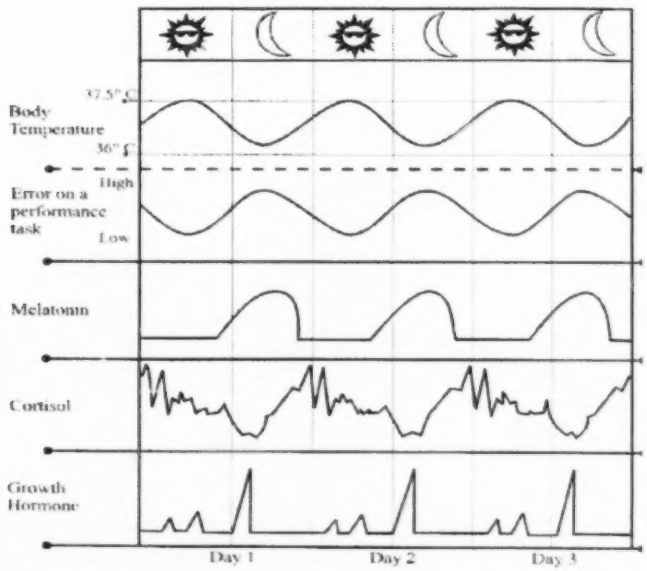
How does your body know what time it is?

Studies in which people lived for weeks in a cave without time cues, such as sunrise and sunset, discovered that there is an internal biological clock. Without external time cues the body follows an internal clock and our daily cycle is actually a little longer than 24 hours.

Environmental cues synchronize internal biological rhythms with the geophysical environment. Under normal conditions in the outside world, we get time cues from the physical environment and the people around us. The most important environmental cue is light. Other possible cues include the change of activity linked to the sleep/wake cycles, and some of our social activities (meals, exercise, etc.) although their exact nature remains a matter of controversy.

Biological Clock Timing

- The most well known body rhythm is body temperature. Temperature is often used to illustrate a 24-hour biological rhythm. The body temperature's high point is in the evening and the low point is in the early morning (around 05:00).
- Various hormones also fluctuate with a 24-hour cycle (melatonin, cortisol, growth hormone – see Figure 4).
- Rhythms affect your performance, alertness, and sleep efficiency.



From *Shifting to Wellness*, Keyano College, 1995

Figure 4 – Example of Biological Rhythms

The Alertness and Sleepiness Rhythm

Your level of alertness and sleepiness determines how well you can sleep, how well you can perform, and whether you are alert and able to think clearly. Figure 5 illustrates the 24-hour variation in sleepiness and alertness. Although individual rhythms vary slightly (morning or evening person), everyone has two distinct peaks and dips.

The greatest increase in sleepiness starts around your usual sleep time and peaks between 03:00 and 06:00. The second peak of sleepiness occurs approximately 12 hours later, between 14:00 to 16:00. Although taking naps is more common in countries with warm climates, midday heat is not the cause of afternoon sleepiness. Studies show the same two peak periods of sleepiness whether people live at the Equator or in North America. Afternoon sleepiness is often called the post-lunch dip, but it's a myth that lunch is the cause. Studies have shown that people feel sleepy in the afternoon even if they have no lunch at all. Moreover, for most people, no similar increase in sleepiness is seen after breakfast or dinner. Peaks and dips in sleepiness depend on our internal biological rhythm, not on factors such as heat or meals.

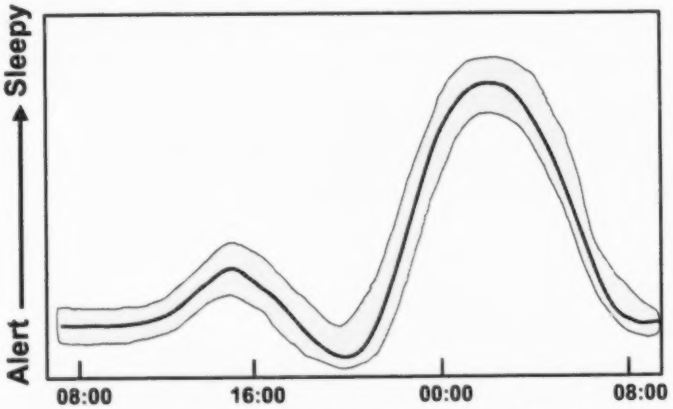


Figure 5 – Sleepiness Over the 24-hour Cycle

In addition to these two peaks of sleepiness, studies have revealed two distinct zones of increased alertness. The first period occurs in the morning sometime after your usual wake time. The second occurs between 20:00 and 22:00, just a few hours before your usual bedtime.

Facts

- Darkness tells your body clock to decrease alertness and get ready for sleep.
- Sunlight in the morning tells your body clock to wake up and be alert.
- Emergencies will temporarily increase your level of alertness and keep you awake.

Morning and Evening People

Individuals have different rhythms. Performance peaks at different times within a couple of hours (morning or evening person).

Are you a morning or an evening person?

These questions will allow you to determine your chronotype (i.e., whether you are a morning or night person). Answer the following questions by choosing the most applicable answer and marking your score.

1. Your day is completely free: What time would you get up?
   - 5 a.m. – 6 a.m. — 5 points
   - 6 a.m. – 7:30 a.m. — 4 points
   - 7:30 a.m. – 9 a.m. — 3 points — My score _____
   - 9 a.m. – 10:30 a.m. — 2 points
   - 10:30 a.m. – noon — 1 point

2. Your evening is free and you aren't working tomorrow. What time would you go to bed?
   - 8 p.m. – 9 p.m. — 5 points
   - 9 p.m. – 10:30 p.m. — 4 points
   - 10:30 p.m. – 11:30 p.m. — 3 points — My score _____
   - 11:30 – midnight — 2 points
   - midnight – 3 a.m. — 1 point

3. Do you find it easy to get up in the morning?
   - not at all — 1 point
   - somewhat — 2 points
   - fairly — 3 points — My score _____
   - extremely — 4 points

4. When you wake in the morning, how do you feel for the first half-hour?
   - very tired — 1 point
   - fairly tired — 2 points
   - fairly refreshed — 3 points — My score _____
   - very refreshed — 4 points

Continued on next page

5. You don't have any commitments tomorrow. Would you go to bed later than your normal time?
   - rarely or never later — 4 points
   - less than 1 hour later — 3 points
   - 1 to 2 hours later — 2 points
   - more than 2 hours later — 1 point

   My score _____

6. At what time in the evening do you feel tired and in need of sleep?
   - 8 p.m. – 9:30 p.m. — 5 points
   - 9:30 p.m. – 10:30 p.m. — 4 points
   - 10:30 p.m. – 11:30 p.m. — 3 points
   - 11:30 p.m. – 12:30 a.m. — 2 points
   - 12:30 a.m. or later — 1 point

   My score _____

7. We have just given you a five-hour workday including breaks. You want to work your very best, you are getting paid for results! Which five consecutive hours would you choose?
   - 11 p.m. – 4 a.m. — 5 points
   - 4 a.m. – 9 a.m. — 4 points
   - 9 a.m. – 2 p.m. — 3 points
   - 2 p.m. – 7 p.m. — 2 points
   - 7 p.m. – midnight — 1 point

   My score _____

8. What time of day would your best (peak) performance be?
   - Between midnight and 4 a.m. — 5 points
   - Between 4 a.m. and 10 a.m. — 4 points
   - Between 10 a.m. and 1:30 p.m. — 3 points
   - Between 1:30 p.m. and 7 p.m. — 2 points
   - Between 7 p.m. and midnight — 1 point

   My score _____

TOTAL _____

What's your total score? If you got from:

35 – 41 definitely morning type
28 – 34 moderately morning type
21 – 27 neither type
15 – 20 moderately evening type
8 – 14 definitely evening type

I am a _____ type

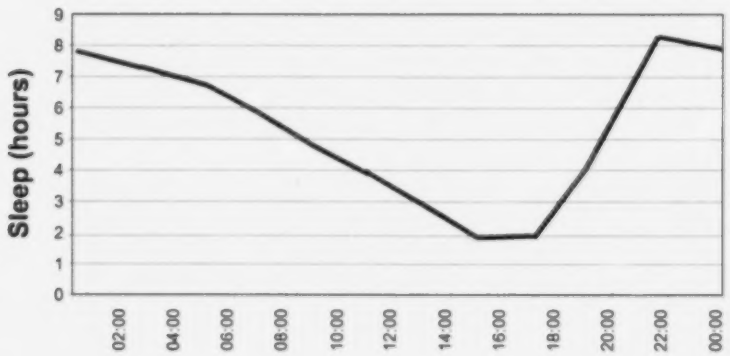
Effects of Time of Day on Sleep

Irregular sleeping times result in a conflict with your biological clock. This means that you will attempt to sleep at times when your body is less inclined to do so. This will:

- Decrease sleep duration
- Alter the sleep structure
- Increase the time to fall asleep

Sleep Duration

Sleep duration depends on time of day. You will sleep for longer periods at night and shorter periods during the day even if you are very tired and sleep deprived. Notice in Figure 6 that if you go to sleep in the morning after working at night, you will sleep for approximately five hours.



Adapted from Shapiro et al., 1997

Figure 6 – Duration of Sleep for Time of Day

Sleep Structure

Our sleep structure varies according to the time of day.

- Slow wave sleep (stages 3 & 4) is longer when you sleep at night and shorter when you sleep in the morning.
- REM sleep is longer at night and in the morning, and shorter in the afternoon.

Wakefulness

It will take you longer to fall asleep during the two times in the day when wakefulness is at its peak. These two periods of wakefulness are late morning and early evening.

What to Remember about Biological Rhythms

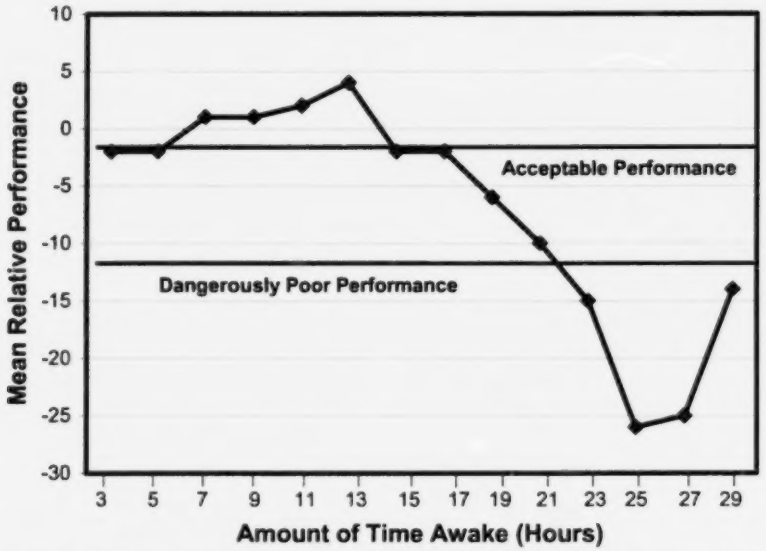
- There are two natural sleep periods: between midnight and 6:00 a.m., and between 1:00 and 3:00 p.m.
- You are most alert in the morning between 9:00 and 11:00 a.m. and in the early evening between 8:00 and 10:00 p.m.
- Light and dark, sleep and wake schedule, and social activities cue your biological clock.
- Working irregular shifts may substantially disturb your biological rhythms.

EFFECTS OF IRREGULAR WORK SHIFTS

Irregular shifts are work schedules where the duration and timing of work periods are highly variable. The conflict between work (at other times than during the day) and your biological clock results in greater fatigue while working and difficulty sleeping when off duty. Fatigue is a major threat to the safety of the marine pilot, as well as to the public. Research has demonstrated that after a 12-hour shift, fatigue impairs reaction times, logical reasoning, hand-eye co-ordination, and decision-making (see Figure 7 as an example). The effects are similar to having a blood alcohol level of 0.048 percent. After 24 hours of wakefulness, performance is similar to that of a person having a blood alcohol level of 0.098%.

The performance of someone who is sleep deprived can be as bad as the performance of someone who is intoxicated!

Figure 7 shows the performance for a single cognitive test presented as a function of time awake. Tests were given hourly starting at 08:00 after a normal night sleep and ended at 13:00 the following day. Note that performance drops off rapidly after approximately 17 hours awake. This situation can be compared to the situation where a marine pilot takes an evening or night assignment after being off duty and spending the day awake waiting for the assignment to begin. If the same data were collected for a shift that started at night and continued into the second night, the degradation would begin sooner and be more severe. Similar results can be obtained for several other cognitive tests including: vigilance, sensory comparison, and psychomotor.



Data is for a 3- to 5-minute grammatical reasoning task taken from 08:00 to 13:00 the next day (Lemond and Dawson, 1999)

Figure 7 – Example of Degraded Performance

How to Define Fatigue?

Fatigue can be defined as a **progressive loss of mental and physical alertness that can end in sleep**.

Physical fatigue usually occurs after strenuous physical activity or very long periods of activity. You feel weaker, have less endurance, and may find that your muscles become cramped, stiff, and sore.

Lack of sleep, sleeping at different times of the day, mental stress, or high mental workload will quickly result in **mental fatigue.** You become increasingly inattentive while trying to concentrate on your tasks. As fatigue increases, your short-term memory becomes less effective and you may forget vital information. Your creativity and decision-making abilities start to wane and you have more difficulty dealing with novel situations. This means you have to work harder to avoid errors. In some situations you may be unable to move for a few seconds, even when you want to. This is called "night shift paralysis". It can happen to individuals who are working a night shift, after they accumulate a sleep debt. You may even suffer "micro-sleep" episodes if you are sleep deprived and engaged in an automatic, routine, or boring activity. When experiencing a micro-sleep you have no control over the task you are performing.

Check Your Level of Fatigue

Score how likely you are to nod off when in each of the following situations:

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

	Score
Sitting and reading	_____
Watching TV	_____
Sitting inactive in a public place (e.g. at a theatre or at a meeting)	_____
As a passenger in a car for an hour without a break	_____
Lying down in the afternoon when circumstances permit	_____
Sitting and talking to someone	_____
Sitting quietly after a lunch without alcohol	_____
In a car, while stopped for a few minutes in traffic	_____
TOTAL	_____

What's your total score? If you got from:

0 to 8	You are well rested
9 to 16	You are somewhat sleep deprived and need to re-examine your sleep habits
17 to 24	You should see your family doctor to find out whether you have a sleep disorder or need to change your sleep habits

Causes of Fatigue

When working at irregular times, you need to balance many factors and activities to optimize your performance and well-being. How long you can work and how much fatigue is accumulated depend on factors such as time of day, the type of work involved, your age, weather conditions, and prior sleep deprivation.

You can divide factors influencing marine pilot fatigue into three categories:

- **Work factors**
  - Irregular schedules (variable time of day)
  - Long periods of duty
  - On-call nature of the work
  - Crew proficiency
  - Workload

- **Environmental factors**
  - Weather conditions and temperature
  - Ship conditions and equipment
  - Lighting
  - Noise level
  - Time of day

- **Personal factors**
  - Biological rhythms
  - Quantity and quality of sleep
  - Physical fitness and health
  - Age
  - Family obligations

Signs of Fatigue

Most people who are fatigued do not realize how tired and impaired they are. We often disregard the warning signs of fatigue. The following list may help you realize when you are drowsy. If you experience one major indicator or three of the other indicators, getting more sleep should be a priority.

Major indicators of severe fatigue	**Other indicators of severe fatigue**
• Eyes go out of focus or close for a moment • Slowed, slurred speech • Blurred vision, seeing mirages ahead • Wandering and disconnected thoughts • Constant yawning • Head nodding • Forgetting to communicate with crew • Incorrect reading of equipment • Forgetting to check ship position on regular basis • Missing a reference point • Not remembering the last command given • Missing radio calls • Giving wrong commands	• Heavy and burning eyes • Headaches, stomach aches • Drowsiness • Inattention to minor, but potentially important details • Reduced morale and motivation • Degraded mental abilities (including memory, decision-making, and perception) • Increased distractibility and irritability • Reluctance to initiate tasks and take command • Reduced sense of humour • Tendency to exaggerate • Tendency to take unnecessary risks • Degraded sense of balance

Impact of Irregular Work on Sleep

Lack of sleep and/or a reduction in sleep quality is one of the main factors affecting your levels of fatigue, mood, health, and ultimately, your performance. We lose sleep either by reducing a single sleep period by a large amount (acute sleep loss) or by building up a sleep debt over time by reducing sleep in consecutive sleep periods (accumulated sleep loss). Attempting to sleep at times when your body is less inclined to do so will disrupt your sleep. The duration of the sleep period will be shorter, and the structure will be altered, resulting in further lost sleep. The on-call nature of the marine pilot job can affect sleep quality, because of the stress of being on standby, and because sleep may be interrupted or shortened by calls from work. While it may be impossible to keep your sleep debt to zero all of the time, you need to make getting enough sleep a priority.

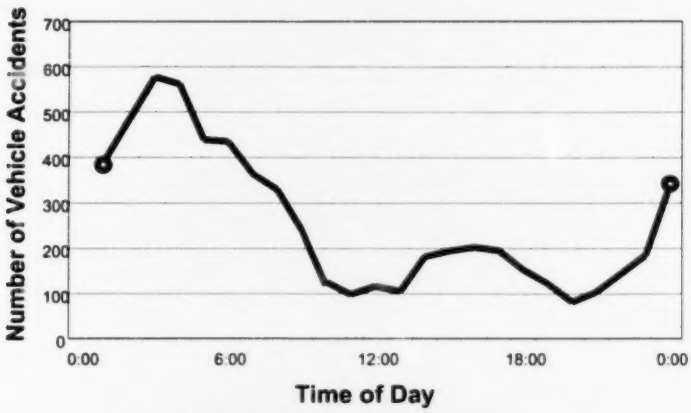
- The only way to correct sleep loss is with adequate recovery (recuperative) sleep.

Impact of Irregular Work on Performance

The effects of biological rhythms make **time of day** the most important factor influencing performance (reducing or increasing reaction time, speed and accuracy).

- Performance at work is significantly lower during the night, and somewhat lower in the afternoon.
- Working at night increases the risk of accidents.

Driving performance is a good example of the negative effect of time of day. Although fewer vehicles are on the road, vehicular accidents attributed to fatigue peak at night (see Figure 8). A smaller increase occurs in the afternoon when our alertness levels experience a minor drop.



Adapted from Mitler et al., 1988

Figure 8 – Number of Fatigue-Related Accidents

Another important factor affecting work performance is **sleep loss** (acute or cumulative). The effects of sleep loss combined with time of day can cause inefficiency, accidents, and even disasters. Many disasters have occurred at night when operators were suffering from sleep loss, e.g.:

- Hinton head-on train collision
- Exxon Valdez grounding and spill
- Chernobyl nuclear core meltdown and fire
- Challenger disaster
- Bophal chemical release
- Grounding of the bulk carrier *Raven Arrow*
- Ramming of the tanker *Hamilton Energy* by the bulk carrier *Nirja*.

Impact of Irregular Work on Health and Mood

Health

Health is a product of many factors. Lack of sleep can lead to many health problems, either directly, e.g., by disrupting immune patterns, or indirectly, e.g., by increasing the risk of accidents. Statistics indicate that 20 percent of shift workers quit their jobs after a very short time because of serious health problems related to working irregular hours. Only 10 percent claim to have no complaints about shift work. That leaves 70 percent who tolerate shift work but have various complaints about it. Research shows that those working irregular shifts suffer more than the general population from the following health problems:

- Gastrointestinal disturbances (heartburn, peptic ulcer, indigestion, gas)
- Cardiovascular disorders (hypertension, heart disease, high cholesterol)
- Sleep disorders (insomnia, chronic fatigue)
- Substance abuse (caffeine, nicotine, alcohol, sleeping pills, alerting drugs)

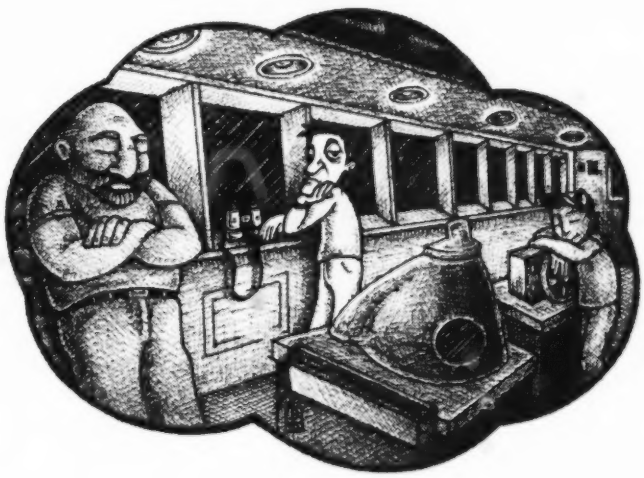
Mood

Fatigue affects your mood. You should be vigilant about how you behave when you are severely fatigued. If you find you are not responding normally, account for the effect and try to temper it.

Recognize the impact of fatigue on your mood: it can make you more depressed, irritable, frustrated, impatient, confused, and less motivated.

Effect of Environment on Sleep, Sleepiness, and Performance

Environmental conditions can affect sleep efficiency, levels of sleepiness, and performance on the job. Lighting conditions can increase your sleepiness and decrease performance. Darkness is a benefit for sleeping but a problem if you need to remain alert. Bright conditions can help you stay alert but glare can interfere with performance. Noise can either soothe you to sleep, or it can keep you awake. Outside an optimum range of temperature, performance will degrade, and sleep efficiency will suffer. Under low workload it may be difficult to fend off sleepiness, particularly if you are sleep deprived.



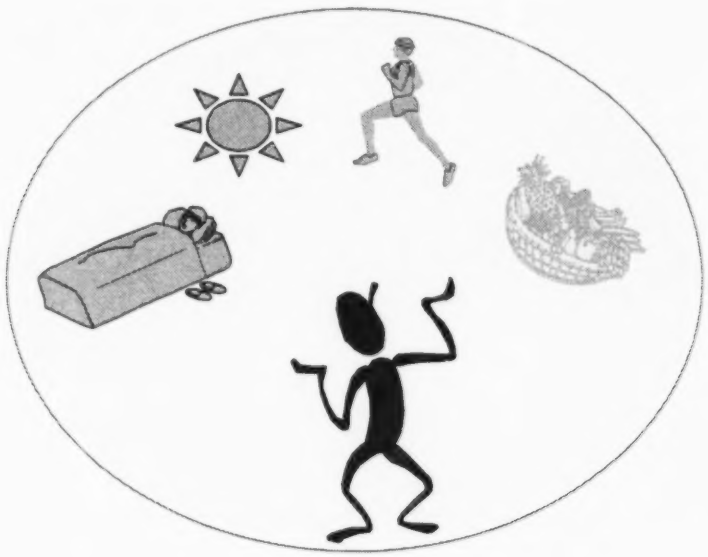
It was hot, quiet and still on the lake that night....

What to Remember about Irregular Work

- Disrupts your biological rhythms
- Decreases your sleep quality and quantity leading to an increase in fatigue
- Negatively affects your mood and health
- Degrades your performance

Neither motivation,
nor training,
nor professionalism
...can prevent your brain from shutting down
when you desperately need sleep!

COPING STRATEGIES



There are several strategies to combat fatigue. Some can be used at home and some at work.

Home Strategies

Sleep Hygiene

Sleep environment

The sleeping environment at home can be improved. First the environment must be **dark**. Darkness is the main body cue to sleep. Creating a dark bedroom during the day means extra thick curtains or wearing eyeshades. The room should be **well ventilated**, and **comfortable**. The **temperature** of the room should **not** be too hot (above 21°C) or too cold (below 17°C). More awakenings and lighter sleep will result if the temperature is not at a comfortable level. Keep the room **quiet** by installing soundproofing in the walls. Wearing earplugs, turning on a fan to create white noise, and asking the family to be quiet can also help. If possible, the room should be isolated from other activity areas in the house to avoid **interruptions**. When not on call you should turn off the phone ringer and make sure you cannot be disturbed by the doorbell.

How Does Your Bedroom Rate?

On a scale of 1 to 5, with 1 being low and 5 being high, rate each of the following elements, and add them up for your total score:

Dark? _____
Well-ventilated? _____
Comfortable room and mattress? _____
Adequate temperature? _____
Quiet? _____
No interruptions? _____

TOTAL SCORE _____

What's your total score? If you got from:

25 to 30	Your bedroom is well designed
20 to 25	Your bedroom is adequate
Below 20	You definitely need to make improvements

Sleep practices

We can do many things to help prepare ourselves for sleep. Developing a before-sleep routine can help trigger our sleep mechanism. Relaxation, reading, or listening to soothing music can help us get ready for sleep. If the day's troubles are on your mind just before you want to sleep, make a list of them and decide on another time to deal with them. Make sure that any medications you may be taking, such as cold remedies, do not contain caffeine, alcohol, or other stimulants. Avoid having any caffeine, nicotine, or alcohol for at least two to four hours before going to bed. These substances will disrupt your sleep and prevent you from getting the proper amounts of slow wave and REM sleep that you need to function properly. Avoid heavy, high-aerobic exercise for at least two hours before bed, since it has a stimulating effect on your body, and increases your metabolism. Finally, if you are hungry, it is wise to eat something light before going to bed.

Do ✔	Don't ✘
• **Establish a bedtime routine**	• **Drink too much liquid**
• **Relax**	• **Exercise vigorously before bed**
• **Read**	• **Consume alcohol, nicotine or caffeine before bed (2-4 hrs)**
• **Inspect labels on cold medications**	• **Go to bed hungry**
• **Nap**	

Napping

One of the best ways to counteract fatigue is to nap. Research has shown that the normal degradation in performance seen on night shifts can be reduced by taking a planned nap before the work period. A well-rested individual can better manage the loss of one night's sleep. Individuals who are already fatigued are likely to suffer a profound degradation of performance. You can't store up sleep by getting more than you need before work, but you can minimize the impact of fatigue by being well rested when you go to work.

Although naps help most people, they can cause insomnia for people who can't fall asleep easily. Under irregular sleep/wake schedules, naps may have to be taken when opportunity arises, rather than when it might best suit the individual's biological rhythms (i.e., at night or in the afternoon). Nap duration will be a function of the interaction between time of day and the amount of prior wakefulness (see Biological Clock). When naps are taken in addition to a longer sleep period, keep the duration between 15 to 40 minutes to avoid waking up from a deep sleep. However, if you are sleep-deprived, deep sleep may still occur in short naps. If you are planning a nap before a night shift, you can schedule a two-hour nap to end one or two hours before you need to work (or drive). This gives you enough time to recover from the sleep inertia that can result from awakening from deep sleep.

Healthy Lifestyle

Lifestyle choices affect your overall health and the quality of your sleep. If you need to change your lifestyle, use all the resources available in your community and workplace. Changes are always difficult to make and are even harder to make permanent.

Fitness

Regular exercise will improve your health and increase your ability to tolerate stress. This can help you to cope with irregular schedules. You can stay fit by getting 30 minutes of exercise at least three times a week. Walking, jogging, and going to a gym can easily fit into a marine pilot's irregular schedule. Remember, don't exercise within a few hours of bedtime.

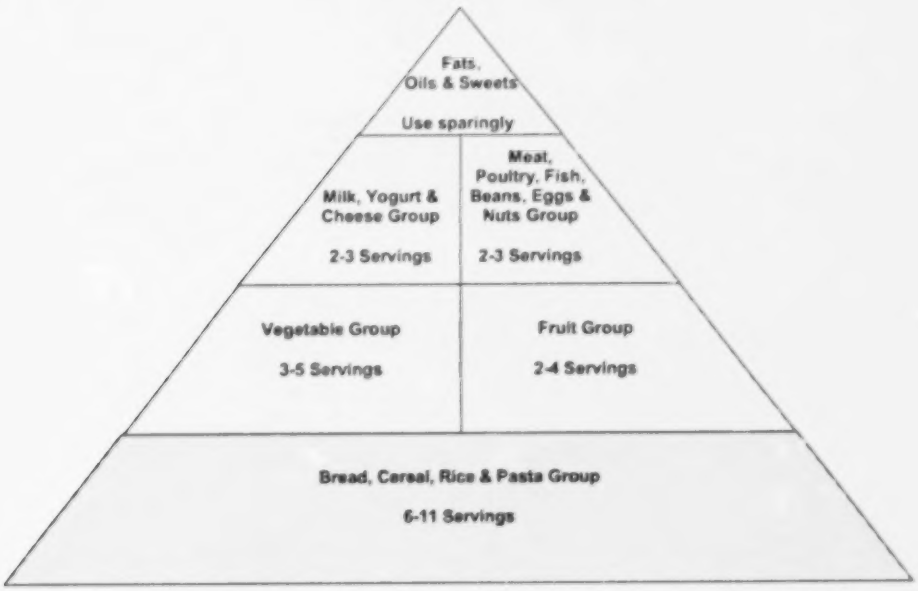
Exercise will also help you maintain an optimal weight, and reduce the risk of sleep apnea, heart disease, and diabetes (Type II). Exercise improves physical well-being, mood, self-esteem, and, to some extent, your job performance.

Diet

Eating well includes keeping a regular schedule for meals and eating appropriately for the time of day. You should eat only easily digestible meals during your body's "night" and keep that heavy meal for another of your mealtimes. Digestion is influenced by the body's biological clock and by the anticipation of eating. The secretion of enzymes necessary to a proper digestion occurs at your regular mealtimes and slows down at night. Therefore, your digestive system is not prepared to digest large meals and hard-to-digest food during the night. Cold drinks before

bedtime are more likely to keep you awake than warm drinks. And don't forget to drink lots of water throughout the day. Staying hydrated helps keep you healthy and alert. You should also be sure to eat a balanced daily diet, as indicated by the Canada Food Guide. The food pyramid shows the approximate proportions of the basic food groups that are needed for a healthy diet (see Figure 9).

Caffeine and nicotine consumption is discussed in Strategies to Stay Awake on page 33.



Healthy eating habits improve your resistance to disease and increase overall energy levels.

Figure 9 – Canada Food Guide Pyramid

Alcohol

Avoid drinking alcohol before going to bed. Alcohol may help you fall asleep but it disturbs your sleep patterns. It will disrupt your sleep by causing early morning or even middle of the night awakening and prevent you from getting the proper amounts of slow wave and REM sleep you need to function properly. Alcohol also restricts respiration. People who snore heavily or have known respiratory problems should limit their ingestion of alcohol and pay attention to the timing of their alcohol consumption, so their body has time to eliminate the alcohol before going to sleep. Alcohol is eliminated at approximately the rate of one drink per hour.

Sleeping pills

Use sleeping pills only on the advice of a physician.

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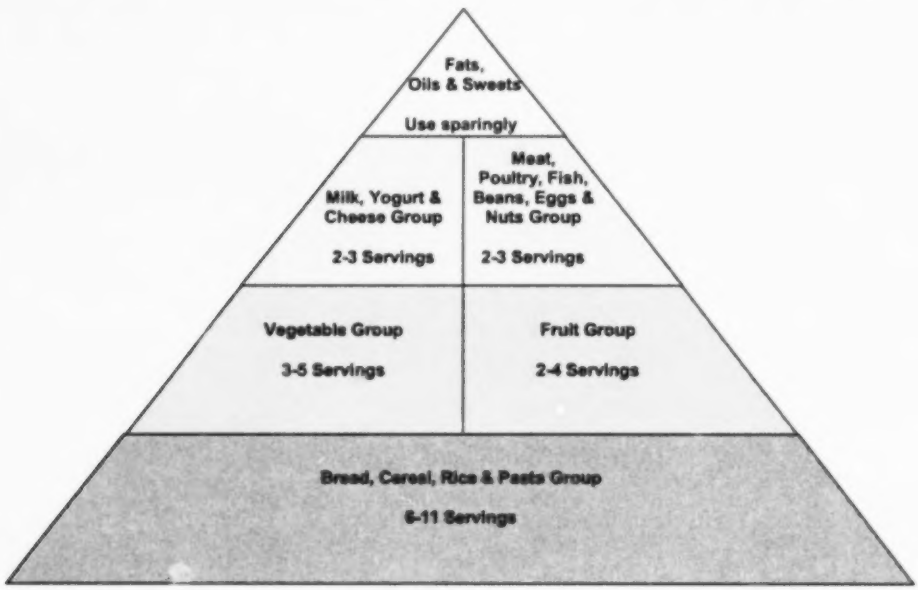

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Sleeping pills

Use sleeping pills only on the advice of a physician.

Natural sleep is best but sometimes we may need help to sleep. Sleeping pills should be taken only for a short time to temporarily help you to sleep in periods of emotional difficulty or stress, or after surgery. Occasionally you can also use sleeping pills to help you sleep during the day, but remember that sleeping during the day will always be more difficult than sleeping at night. If getting enough sleep continues to be a problem, you may need to consult a professional to help you find the real causes (medical, behavioural, or psychological) and start a treatment to cure the problem. Sleep brought on by sleeping pills is usually abnormal, and typically reduces REM and slow wave sleep. The sleep induced by pills does not necessarily improve mental performance on the following day; often performance is reduced (hangover effect). The hangover effect varies according to the type of pill and the rate at which your body can get rid of the drug. This depends on your health, age, the type of pill, and its dosage. Sleeping pills may cause anxiety, nausea, confusion, digestive upset, dizziness, and frequent urination.

Sleeping pills slow down respiration and should never be taken if you have respiratory problems.

NOTE: If you stop taking pills after long-term use, be prepared for rebound insomnia because your body has been accustomed to relying on the pills to initiate and maintain sleep. Sleeping pills do not directly address the actual cause of the irregular shift worker's sleep difficulty. Whether sleeping pills can reset or synchronize your body rhythms remains a matter of controversy.

Support from family and friends

One of the biggest challenges for a marine pilot is finding time to spend with family and friends. To the family, a day off can look like a good day to do errands or play. To the marine pilot just returning from a long night assignment, that day looks like a good time to sleep. **Family obligations often compete with your need for sleep.** The first step is to communicate with your family and friends. Talk with them and get their help in deciding how to get enough sleep and still keep up with family responsibilities and social events. Time management and compromise are the keys to successful fatigue management for you, your family, and your friends. Make sleep a priority followed immediately by spending time with your family. You can also help them understand the difficulty of irregular work and the fatigue you are experiencing by showing them this booklet and talking about some of the more important areas that involve them.

Time and Stress Management

Being unable to balance work, family, and social obligations, as well as find time for yourself, can cause stress and could lead to illness. Having unrealistic demands on your time can cause stress. Disruption of your biological clock and its impact on sleep can also result in some stress. Planning ahead, prioritizing activities, learning to say no, and delegating tasks are essential skills that need to be learned and continually practised. Physical exercise and/or relaxing activities will help reduce your stress. Making time for sleep, family, and friends will improve your well-being. Say no to activities that won't fit your time schedule or that will compromise your time to sleep or to be with your family too much. Eat healthy meals regularly and restrict your alcohol, nicotine, and caffeine intake. **Know your limits!**

What to Remember about Home Strategies

- Improve your sleep environment and sleep practices to obtain the best sleep you can.
- Adopt a healthy lifestyle and avoid excessive intake of caffeine and alcohol.
- Educate friends and family about the difficulties of irregular work and the importance of getting sufficient sleep.
- Reduce the impact of stress as much as possible by managing and scheduling activities.

Work Strategies

Napping

Sleep is the best countermeasure against fatigue and poor performance. Short naps have an extraordinarily recuperative effect and help maintain performance within acceptable levels. Several factors should be considered when planning a nap, including work demands and nap timing. Marine pilots may consider taking naps during a long lake crossing, while waiting for long periods at a lock or to board a ship, and while ships are anchored. Napping during these times is at the discretion of the marine pilot and will depend on other factors, such as weather conditions, crew competency, and traffic. Naps taken at work depend on opportunity but, if you can, you should choose to nap at times when you will fall asleep easily (consider your biological clock). Naps should be either short (10 to 40 minutes) or long (90 minutes or more) like your sleep cycle, to avoid the possibility of feeling drowsy upon awakening (called sleep inertia). In any case, allow some time to wake up and recover from **sleep inertia**. You can use a mask and earplugs to help you nap in situations where you can rely on someone to wake you up.

Guidelines for Napping at Work

Planning	Nap prior to anticipated sleep loss or during your shift, when you can do so safely.
Environment	If possible, nap lying down in a quiet place and make sure you will be awakened when necessary.
Timing	If possible, nap when the body is most receptive (afternoon or night).
Duration	The nap should be shorter than 40 minutes or longer than 90 minutes.
Awakening	Beware of sleep inertia effects, which can last 15 to 20 minutes at night and five to ten minutes during the day.

Strategies to Stay Awake

Stimulants

Caffeine is the most common stimulant used to maintain alertness, particularly when we are very tired. The strong stimulating effects of caffeine peak within 30 minutes to one hour, and it may take up to eight hours for it to clear out of your system. As a stimulant, caffeine must be used carefully, since it increases heart rate, blood pressure, and urination. If used too much, and for too long, caffeine may be addictive. Heavy users (more than four cups per day) who quit may suffer withdrawal symptoms such as headaches, restlessness, vomiting, depression, and fatigue. These symptoms disappear after several days. If caffeine is ingested as large quantities of coffee or tea, the tannins and acids may be harmful to the stomach, particularly during the sleep period, when digestion is slowed down. Caffeine is found in coffee, tea, cola drinks, chocolate, and a variety of drugs (see Figure 10). Caffeine consumption prior to sleep or in large doses increases awakenings, reduces slow wave sleep, and shortens the sleep period. However, combining the arousal effect of caffeine and napping can be very effective. When planning a short nap (less than 20 minutes) you can take caffeine just before the nap and benefit from the peak effect of caffeine just when you wake up. Do not drink coffee before you plan to take a long nap. **Timing and moderation are the keys to effective use of caffeine.**

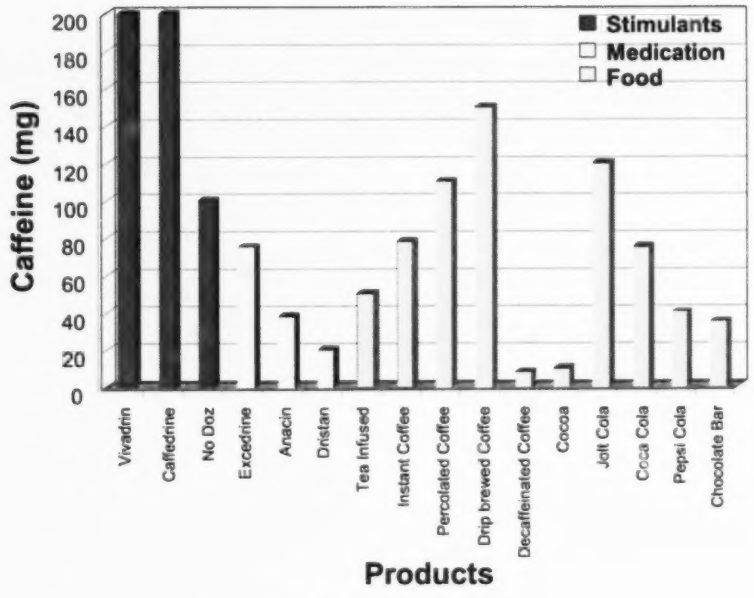

Figure 10 – Sources of Caffeine

Nicotine has two opposite effects depending on its concentration in the blood. At low concentration it will produce relaxation. At higher blood concentration it produces a stimulant effect. Smokers may take longer to fall asleep than non-smokers and their sleep duration is reduced by 30 minutes per night on average. Habitual smokers who try to stop smoking will

report sleep disturbances. The effects of nicotine on alertness are short lived and are not sufficient to overcome sleepiness due to sleep loss. Smoking also contributes to health problems such as lung cancer, heart disease and respiratory disorders.

Bright light

Light has been shown to have a stimulating effect in some situations. The light panels used to treat Seasonal Affective Disorder (SAD) can also help improve alertness in some individuals. Light and exercise could have an interactive effect that is slightly better than light alone. More research is needed before these methods can be generally applied.

Exercise

Exercise can also help to keep the body from feeling sluggish. Getting up, stretching, and moving around when you have a few minutes between tasks can revive you for a short time, depending on how fatigued you are. Exercise provides a temporary stimulating effect that lasts for 20 to 30 minutes.

Other

Other strategies involve noise, cool air, and mental stimulation from conversation. Sounds can help the marine pilot stay alert, providing they are intermittent and loud enough. Casual conversation can help keep people awake and on task provided that it is not too engaging. Stepping out into the cool air and taking a walk around the deck will help to shake off some of the sleepiness.

What to Remember about Work Strategies

- Be opportunistic and take advantage of the recuperative value of naps.
- Use caffeine wisely by choosing the proper timing and quantities.
- Short exposure to bright light can improve your alertness.
- Exercise, fresh air, and noise can give you temporary relief from sleepiness.

Driving Strategies

Effects of Fatigue on Driving

Fatigue can impair functioning while driving. There is a strong connection between fatigue and driver errors resulting in an accident. Fatigue affects your driving performance even before you actually fall asleep behind the wheel. Fatigue will delay reaction time, decrease awareness, and impair judgment. Driving is a complex mental and physical task that requires concentration and skill to maintain adequate performance. Performance of sleepy drivers can be worse than

that of intoxicated drivers! Being aware and managing the impact of fatigue can prevent car incidents and fatalities on the road.

Signs of Driver Fatigue

The most important strategy you can follow is to catch yourself before you fall asleep behind the wheel. You can do this by paying attention to the warning signs of fatigue (see page 23). Some signs, such as yawning, excessive blinking, disconnected thoughts, difficulty keeping your head up, or nodding, are not specific to the driving situation. However, some are more specific to the task. These include not being aware of the past few kilometres, weaving into another lane or onto the shoulder of the road, being unaware of traffic around you, missing traffic signs, finding that you have decelerated unintentionally, or missing your exit. These are all signs of sleepiness that needs immediate attention.

Strategies to Stay Alert

Two types of strategies can be used to combat fatigue once you have recognized the signals that tell you your body is tired and needs sleep. The first will help you to drive until you to find a safe place to get some rest and the second will help you to recuperate.

The temporary strategies available to you while driving include turning on the radio to a talk show or fast music, opening the window for fresh air, or turning on the air conditioning. These tactics can only help you drive for another kilometre or so before the signs of fatigue come back even stronger. Be aware that they only mask fatigue, they don't actually reduce it.

You can also choose more recuperative strategies, such as stopping in a safe place to take a short nap (10 - 20 min) or stopping to have a coffee. These strategies can help you if you are not too far from your destination. Be aware that the stimulating effect of caffeine will wear off quickly, especially if you are very tired. Another possibility is to combine the beneficial effect of a nap with the stimulating effect of coffee upon awakening. This combination has been found to be an effective short-term measure to reduce fatigue.

What to Remember about Driving Strategies

- A responsible driver does not drive if under the influence of fatigue.
- Fatigue affects your driving performance by increasing the duration of your response time and decreasing your concentration.
- It is important to pay attention to the warning signs of fatigue (weaving, not being aware of surroundings, and missing signs and exits).
- Strategies such as getting fresh air and turning on the radio only mask fatigue, they don't actually reduce it.
- Short naps and coffee can help you if you are not too far from your destination.

HELPFUL HINTS

Essential Strategies

- Know your sleep needs and limitations
- Pay attention to your biological rhythm.
- Make sleep a priority.
- Start your work with zero or minimal sleep debt.
- Watch for the signs of fatigue.
- Use alerting strategies at work.
- Eat healthy foods and exercise regularly.
- Consult your physician if you think you have a sleep disorder.

Napping Tips

- Use a longer nap (over 90 minutes) to decrease your sleep debt.
- Use a short nap (10 to 40 minutes) to increase your alertness when tired.
- Time your naps to your body clock.
- Beware of the effects of sleep inertia.
- Don't nap if you have insomnia.

Food Tips

- Eat healthy meals at regular times.
- Avoid high-fat and spicy foods at night.
- Limit caffeine.
- Avoid caffeine, alcohol, and heavy meals prior to sleep.
- Eat a light snack at night.
- Drink water (but not just before bedtime).

Foods to Avoid on the Night Shift

- High-fat food
  - Fried food
  - Pastries
  - Potato and corn chips
  - Subs and pizza
  - Whole-milk dairy products
  - Fatty meat

- Foods that promote stomach irritation
  - Spicy food
  - Excessive coffee or tea (including decaffeinated)
  - Tomato juice

Tips to Improve Family and Social Issues

- Be flexible.
- Manage your time while on your "tour de role".
- Plan sleep as well as other activities when not on your "tour de role".
- Educate the family on fatigue issues.

SUGGESTED READING

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